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SERVICE TO THE STATE OF UTAH

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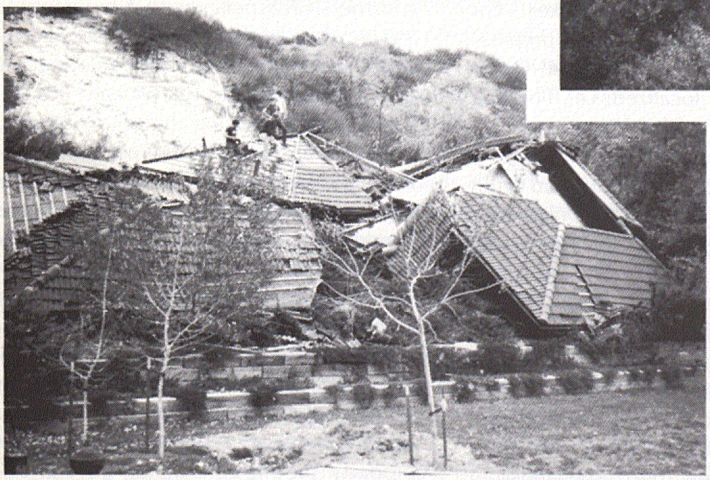

UTAH'S GEOLOGIC HAZARDS

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Cover Photos: Flooding, sinkhole and mudflow damage: Utah's geologic hazards.

Survey Notes is published quarterly by **Utah Geological and Mineral Survey**, 606 Black Hawk Way, Salt Lake City, Utah 84108 (801) 581-6831. The UGMS inventories the geologic resources of the state, identifies its geologic hazards, disseminates information concerning Utah's geology, and advises policymakers on geologic issues. The UGMS is a division of the Department of Natural Resources. Single copies of *Survey Notes* are distributed free of charge to residents within the United States and Canada. Reproduction is encouraged with recognition of source.

FROM THE DIRECTOR'S DESK

UGMS Helps Identify and Mitigate Geologic Hazards

THIS issue of Survey Notes features several hazards studies of the UGMS, such as landslide inventories and compilation of hazards information, so that the public as well as state agencies will know where hazards can generally be expected and where to locate information about them. Approximately one-third of the UGMS scientific effort goes into hazards studies (the other two-thirds is for the identification of Utah's economic resources and for geologic mapping of areas of the state). Utah is blessed with the benefits as well as the hardships of geologic hazards...many of the steep mountains and ski slopes are the result of faulting along the Wasatch fault, the Great Salt Lake is an important ecomomic resource as well as a disconcerting economic hazard, and even landslides and rockfalls are an integral part of most Utah vistas in more rugged terrain. The identification and understanding of these hazards make it possible for governmental entities and individuals to take rational actions to lessen their own vulnerablilty to them. There are four general ways to successfully cope with most hazards: avoidance, control, engineering and preparedness. Some hazards are more difficult to avoid than others: it is difficult to avoid ground-shaking from earthquakes. For such a hazard, engineering and preparation are the proper responses. Other hazards are more localized, i.e., flooding along rivers or along lake shores.

One article features landslides as a hazard, the type of hazard that can often be avoided if it is recognized. Unlike river flooding, high groundwater, and lake level fluctuations, landslide-prone areas are not easy to delineate. But, as we look back at the landslides of 1983-85, and as we see this year's landsliding season begin, it is clear that nearly all of the large landslides and most of the smaller landslides are remobilized portions of prior landslides. We knew the Thistle landslide, for instance, had moved in whole or in part as many as four times since Lake Bonneville time (15,000 years ago), because before 1983, its toe had disturbed the shoreline that the ancient lake had cut across it. Other landslides have been moving off and on for the last few decades, as well as in prehistoric time, such as the slides in Manti and Ephraim Canyons that have been monitored and studied by USGS geologists in detail for 15 years. We watch the progress of a few Utah landslides just by the maintenance work done year after year to keep the highways passable, such as in Fairview Canyon and in East Canyon. The railroads unwittingly provide us with valuable evidence of landslide movement by their problem-maintenance areas such as at Soldier Summit. Some of the most subtle landslide features to recognize can be the most dangerous. Small landslides in or beside steep drainages can be hit by a rush of water from cloudbursts or from rapid snowmelt, mobilize, and become mud flows, such as in Rudd Canyon. Often landslides occur in normally stable areas that have been disturbed by construction activities. Deposits along the upper shorelines of Lake Bonneville seem to be popular targets of such abuse by developers. All of these types of landslides can be identified by trained geologists and the UGMS believes that by identifying previous landslides and landslide susceptible terrain, we provide information that can be used by individuals and organizations for making choices. In general, landslides and certainly the paths of mudflows are best avoided when choosing a house or designing a subdivision. We would like to think that by providing information about unstable areas we provide the good news of where the land is relatively stable.

Often individuals telephone the UGMS and want this type of information where it has not yet been collected. They request an evaluation of their property or a property they're considering buying. Be-

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UTAH'S GEOLOGIC HAZARDS

by
Gary E. Christenson

MANY of the geologic processes which have shaped Utah's scenic landscapes and rugged topography over the last few million years remain active today. Ironically, many of these processes, which have produced a natural environment that most Utah residents find desirable, present serious hazards to both lives and property. Active uplift of the Wasatch and other mountain ranges is episodic and is accompanied by large earthquakes. The resulting steep mountainsides and high elevations subject to heavy precipitation are prone to rapid erosion, slope instability, and are a major source of flood waters. Utah is a natural laboratory for the study of these geologic processes because they are active on a human time scale as well as on a geologic time scale. Many occur often enough to be witnessed and recorded by scientists and the data gathered can be used to understand and predict events and to help protect lives and property. These events and processes are commonly termed geologic hazards because often they adversely impact man and his works. Geologic hazards are not random, unpredictable "acts of God" from which there is no escape, but are natural processes which occur and reoccur in specific areas under specific sets of conditions. The degree to which we understand the phenomena determines our ability to predict hazard events. Although understanding of Utah's geologic hazards has not progressed to the point of allowing reliable predictions of when events will occur, much information is available on the location, extent, and nature of hazard areas.

The Utah Geological and Mineral Survey (UGMS) maintains a continuing program of identifying geologic hazards and advocating actions that take these hazards into consideration. Hazards-related activities are administered under the Applied Geology Program at the UGMS, and to date these activities have concentrated on responding to requests from various governmental entities for geologic expertise in the siting of critical facilities and for detailed, local geologic hazards mapping, principally for city planners. The UGMS also provides advice and assistance in response to hazard events, and publishes hazards information as it becomes available either from within the UGMS or from external sources. The UGMS has long recognized a need by local governments and others for statewide hazards information. In 1985, the UGMS was successful in acquiring Federal and State funding to begin our Hazards Information Compilation Project. The ultimate goal of the project is to compile all existing geologic hazards information in the state and to produce maps depicting hazard areas.

Geologic Hazards of Utah

Flooding

Stream flooding from cloudburst storms and snowmelt runoff is probably the most widely distributed and frequently occurring of Utah's geologic hazards. Spring snowmelt is responsible for most flooding along Utah's streams, and is to some extent predictable. Summer cloudburst floods account for more localized but often very destructive flooding and can occur with little warning. Another type of flooding which has caused considerable damage in Utah is the rise of lake levels, particularly of Great Salt Lake and Utah Lake (fig. 1). Flooding may also result from a rise in the shallow water table in response to high stream and lake levels, heavy precipitation, and excess irrigation. Flooding of topographically low areas and subsurface structures such as basements and septic tank soil absorption fields is the major impact of rising water tables.

Figure 1. Flooding at the Great Salt Lake.

Although flooding has been reported along nearly all of Utah's major streams at some time, it occurs most commonly in streams draining the Wasatch Range, Bear River Range, Uinta Mountains, and the high plateaus of central Utah. Lake flooding is confined to the closed basins of western Utah, and damage is greatest along the Wasatch Front where there is extensive development along the Great Salt Lake and Utah Lake. Shallow ground water is also found in many of the basins of western Utah, and the highest water tables and greatest reported flooding has occurred along the Wasatch Front, the valleys of the Wasatch Range and Uinta Basin, and the Sanpete and Sevier Valleys of central Utah.

Slope Failures

The slope failure hazard in Utah was dramatically demonstrated in 1983 when the Thistle landslide blocked Spanish Fork Canyon and severed highway and rail connections between the Wasatch Front and areas to the east. This landslide was the most costly in U.S. history and has had lasting adverse economic impacts in Utah. Thistle was a large but relatively slow-moving landslide, technically termed an earth flow, that had moved repeatedly in the past. It was one of many ancient landslides, chiefly slumps and earth flows, that was reactivated by an extended period of much above-normal precipitation that began in September, 1982. These types of movements represent but one aspect of the slope failure hazard. Debris flows and mud flows are another type of failure common in Utah. They may be generated by cloudburst floods, but most recently have occurred during spring snowmelt as slopes with thick accumulations of colluvium and debris become saturated and fail. If a failed mass reaches a steep drainage where additional water is available, it may be mobilized into a slurry of mud and rocks that travels down the channel, eventually depositing its debris at the canyon mouth. Many such debris flows occurred in 1983 and 1984, with the most damaging occurring in Davis County (fig. 2). Other types of slope failure hazards found in Utah include rock slides and rock falls. These generally occur in areas of steep, barren rock outcrop and in February, 1986, damaged an aqueduct in Provo Canyon, contaminating a part of Provo City's water supply.

Slope failures are most common in moist, higher elevations in areas of steep slopes and slide-prone geologic materials. These conditions exist chiefly in the Wasatch Range and Uinta Mountains of northern Utah and in the high plateaus and steep canyons of central and southern Utah (fig. 3). Ancient landslide complexes with varying degrees of modern activity occur throughout these areas. In 1983 and 1984, major slope failures (debris flows, slumps, earth flows) and resultant damage occurred in the Wasatch Range and in the plateau areas of Sevier and Sanpete Counties. Excluding rock-fall hazards, slopes in the more arid parts of the Colorado Plateau of eastern Utah are generally stable under present conditions. Slope failures in the mountains of the Basin and Range of western Utah are also less common due to their aridity and the predominance of competent rock types, but rock falls and debris flows do occur.

Earthquakes

Earthquakes are a many faceted hazard and have the potential for inflicting a greater loss of life and property than all other hazards in Utah. Earthquakes may have varied and wide-ranging effects, depending on their size and the geologic conditions in the affected area. Small magnitude earthquakes are common in parts of Utah but cause little damage. Although no large earthquakes have occurred

Figure 2. Damage in the Farmington area from the Rudd Canyon debris flow.

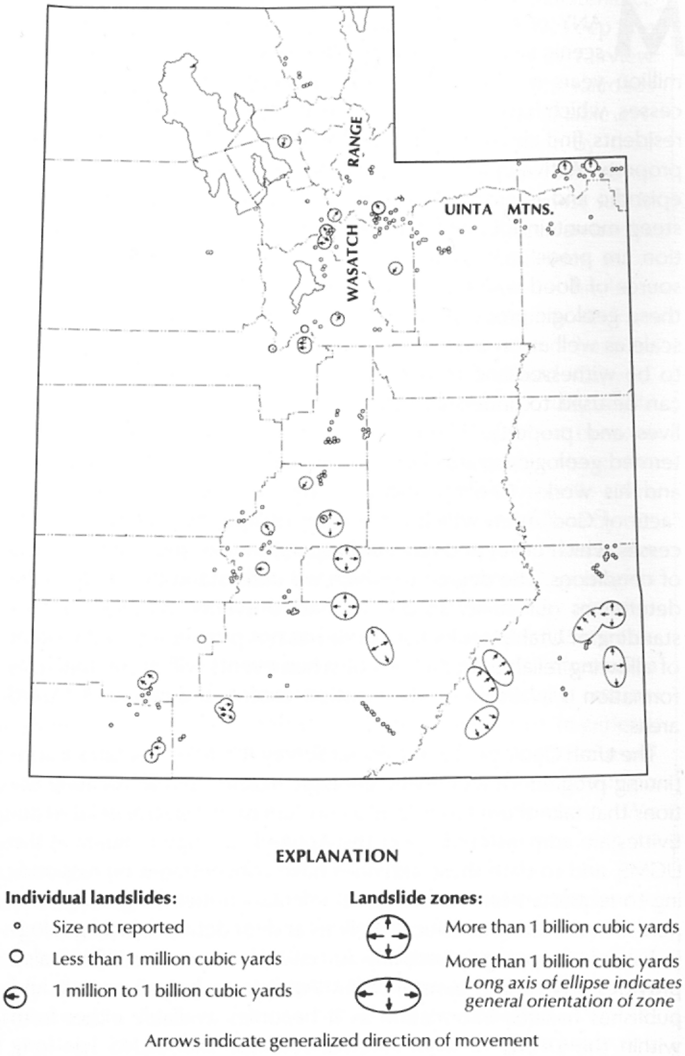

Figure 3. Major landslides in Utah (adapted from Shroder, 1971). Map shows chiefly slump/earth flow failures and has not been updated to reflect movements after 1971.

in densely populated areas of Utah, those that have occurred in neighboring states (1959 Hebgen Lake, Montana; 1983 Borah Peak, Idaho) demonstrate well the type of effects that can be expected in Utah. Hazards accompanying earthquakes include ground shaking, surface fault rupture, soil liquefaction, and seismically induced slope failure and flooding. Severe ground shaking represents the greatest hazard during an earthquake because it affects large areas and induces many of the secondary effects associated with earthquakes. In the 1985 Mexico City earthquake, nearly all damage was caused by ground shaking alone. Flooding resulting from earthquakes may be caused by increased spring discharge, deflection of surface drainage, dam failure, tectonic subsidence, and/or seiche waves generated in standing bodies of water.

The earthquake hazard in Utah and particularly in the Wasatch Front has been the subject of intensive study in recent years. For a complete discussion of the hazard, see Don Mabey's article in the Winter, 1985 edition of Survey Notes entitled Earthquake Hazards in Utah. In general, the area of greatest earthquake hazard in Utah extends in a north-south zone through the center of the state (fig. 4). This zone is characterized by numerous active faults and relatively high levels of historic seismicity and is a part of what is termed the Intermountain seismic belt extending from Montana to Nevada. The hazard is considered greatest in the Wasatch Front area along the Wasatch, East Cache, and Hansel Valley faults. However, a significant hazard is present in southern Utah along the Hurricane, Washington, and Sevier-Elsinore faults. Faults are found in western Utah, but geologically these appear less active and they lack associated seismicity. Because of a lack of seismicity and active faults, the earthquake hazard in the Colorado Plateau of eastern Utah is also considered to be low relative to the Intermountain seismic belt.

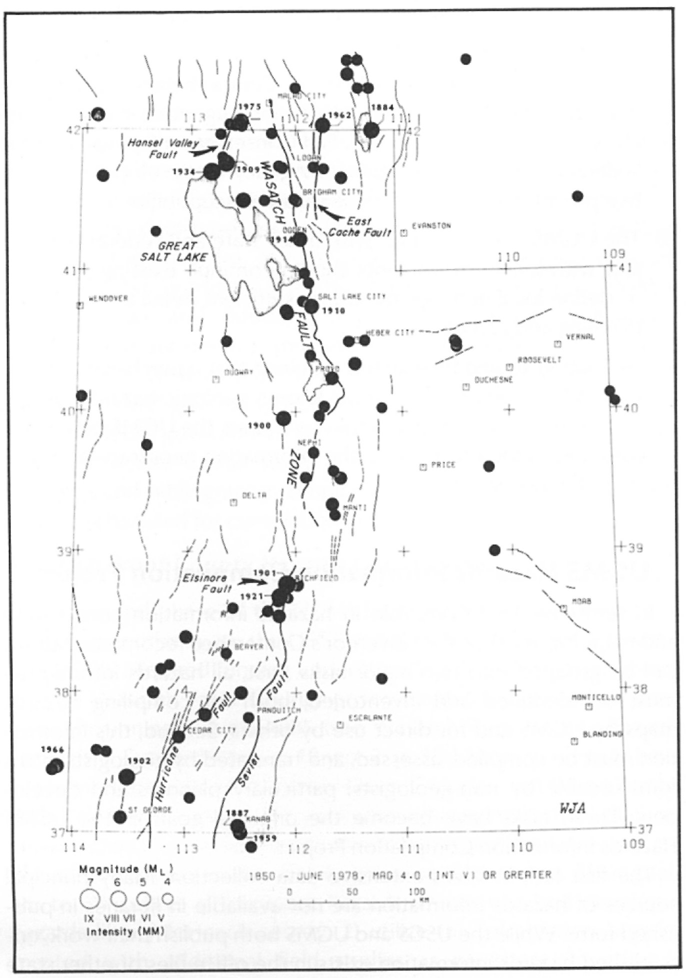

Figure 4. Historic earthquakes of magnitude four or greater and possibly active faults in Utah (Arabasz and others, 1979).

Adverse Soil Foundation Conditions

Several types of naturally occurring materials are deleterious to foundations and pose a threat to permanent structures. These materials include expansive, collapsible, and gypsiferous soils. Expansive soils are those containing high percentages of montmorillonitic clays which expand and contract when wetted and dried. Forces generated during expansion and ground subsidence accompanying shrinking are sufficient to crack walls and foundations of some structures. Subsidence causing structural damage may also occur in soils subject to hydrocompaction. These soils are termed collapsible because they undergo a volume decrease when saturated. Collapsible soils occur in geologically young materials (debris- and mud-flow deposits, wind-blown silt) characterized by a loose "honeycomb" structure resulting from deposition in a moisture-deficient environment. Once saturated, this soil structure collapses and the ground surface settles, causing damage to overlying structures (fig. 5). Subsidence may also accompany dissolution of gypsum or other salts if present in foundation materials.

Expansive soils are found in many parts of Utah and generally result from the weathering of shale. They are present locally along the Wasatch Front, particularly in Utah County, but are more widespread in the Colorado Plateau of central and southern Utah . Collapsible and gypsiferous soils are well known to occur in southwestern Utah, particularly along the base of the Hurricane Cliffs (Cedar City, Hurricane), and have been found to the north in the Scipio and Nephi areas.

Other Hazards

Many other geologic hazards, generally less widespread, are found in Utah. Subsidence and ground cracking, probably due to ground-water withdrawal, have occurred in the Milford area, and similar subsidence may potentially occur in other areas where un-

Figure 5. Damage to a home in Cedar City caused by subsidence in collapsible soils (hydrocompaction).

derground fluids are "mined," including oil and gas fields. Collapse of underground mines and failure of plugs in vertical shafts has caused local surface subsidence. Subsidence due to compression and decomposition of organic materials in bog or swamp areas and the natural production of methane from such deposits (as along the east shore of Great Salt Lake) may pose hazards to structures. Snow avalanches also present hazards to structures and corridors (highways, pipelines) as well as to skiers and ski areas. Soil erosion and stream downcutting threaten to reduce the productivity of Utah's agricultural and range land by removing top soil and lowering water tables, and sediment carried in streams from these areas fills reservoirs and debris basins. Shifting sands in the more arid parts of the state also present hazards. Although no active volcanoes are found in Utah, lava flows less than 1000 years old are found near Milford, and periodic basaltic volcanism has occurred during the Quaternary period in the area from Delta to St. George. A more significant volcanic hazard is presented by a possible influx of airborn ash from explosive volcanic activity in neighboring states to the west.

Hazards Information Needs

In Utah, the responsibility for planning and zoning with regard to geologic hazards lies principally with city and county governments. Ways in which hazards are addressed varies considerably among jurisdictions, but most commonly hazards are addressed in subdivision ordinances regulating new construction whereby geologic reports addressing hazards can be required prior to plat approval. In rural towns and counties in Utah, local planning commissions are generally relied upon to determine where hazardous conditions exist and where more detailed study is necessary. In urban communities, particularly along the Wasatch Front, local governments have enacted hillside or sensitive lands ordinances which delineate areas requiring more detailed hazards assessments. In some cases delineation of potentially hazardous areas is based largely on slope considerations, but several communities have contracted to have geologic hazards maps prepared at scales ranging from 1:1,200 to 1:30,000. Salt Lake City, Provo, Ogden, and Mapleton have passed hazards ordinances based on such detailed mapping identifying surface fault-rupture, landslide, and flood hazard zones and areas of possible foundation and ground-water problems. Other cities in Utah will be evaluating the effectiveness of these ordinances in controlling development in hazard areas and reducing losses from hazard events. At the county government level, only Davis County has completed detailed county-wide hazards mapping. However, this mapping was not incorporated into city or county hazards ordinances and also has not been updated to reflect knowledge gained from recent events. In other counties, progress toward county-wide hazards mapping has varied depending on degree of development, severity of hazards, and awareness of county officials.

Clearly, there is a need for hazards information by local governments throughout the state. Considerable hazards information exists but is not generally available to local governments or the public and is not in a form comprehensible to the non-geologist. Additional information is rapidly accumulating as a result of: 1) the U.S. Geological Survey (USGS)-sponsored National Earthquake Hazards Reduction Program (NEHRP) along the Wasatch Front, and 2) research efforts by the USGS, UGMS, and Utah universities in response to the floods, debris flows, and landslides of 1983-84.

In 1983, the USGS expanded the NEHRP to include an Urban and Regional Hazards element and identified the Wasatch Front as the highest priority under this element for funding during the following three years. This program is supporting many research efforts covering all aspects of the earthquake hazard, and results are scheduled for publication in 1987. Some of the many topics being studied include surface fault-rupture hazard and earthquake history along the Wasatch fault, liquefaction potential in Wasatch Front Counties, seismic slope stability in parts of Davis and Salt Lake Counties, and ground response to seismic shaking in Utah and Salt Lake Counties. Studies will continue beyond the 3-year schedule, but by the end of the program we will have a much greater understanding of the earthquake hazard along the Wasatch Front.

The disastrous springs of 1983 and 1984 generated much interest in the study of flood and slope failure hazards in Utah. Technical conferences addressing these hazards produced much valuable information (Bowles, 1985; Kay and Diaz, 1985), and a policy-oriented conference convened by Governor Matheson in 1983 helped define tasks and responsibilities of state government in hazards assessment. The purpose of the 1983 Governor's Conference on Geologic Hazards was to evaluate information needs and recommend State legislative and executive actions to mitigate hazards. A previous conference called by Governor Calvin Rampton on December 17, 1967, focused on presentations by technical experts. The 1983 conference included technical presentations but emphasized working groups soliciting advice and recommendations from geologists, planners, officials at all levels of government, and the private sector. The principal recommendations resulting from this conference which relate to identification and mapping of geologic hazards and dissemination of hazards information include the following:

1) The UGMS hazards identification effort should be reoriented to a 2-year program to produce 1:500,000 scale maps of Utah depicting geologic hazards.
2) The UGMS and the Division of Comprehensive Emergency Management should work with Federal agencies including the USGS, U.S. Forest Service, U.S. Soil Conservation Service, and the Federal Emergency Management Agency to develop a cooperative program to complete State hazard susceptibility maps.
3) The UGMS in cooperation with other State and Federal agencies and with local governments should continue existing programs to define local geologic hazards in sufficient detail to guide local planning and zoning.
4) Legislation should be enacted requiring that a purchaser of property in Utah be informed of all known geologic hazards relating to the property and that within two years the UGMS be authorized and funded to provide the information necessary to implement the legislation.

UGMS Hazards Information Compilation Project

In terms of the UGMS role in hazards information compilation and mapping, most of the Governor's Conference recommendations can be grouped into two major tasks. First, all hazards information must be identified and inventoried, both for compiling hazards maps by UGMS and for direct use by others. Second, this information must be compiled, assessed, and translated by geologists into a form useable by non-geologists, particulary planners and developers. These tasks have become the principal goals of the UGMS Hazards Information Compilation Project.

The first task involves extensive data collection. Many principal sources of hazards information are not available in libraries in published form. While the USGS and UGMS both publish their work, unpublished hazards information exists in the office files of other state and federal agencies and private geotechnical consultants. Geologic hazards studies and information are commonly found in agencies such as the U.S. Bureau of Reclamation, Soil Conservation Service, Forest Service, Army Corps of Engineers, and Bureau of Land Management; and in the State Divisions of Water Resources; Water Rights; Oil, Gas, and Mining; Facilities Construction and Management; and Environmental Health and the State Department of Transportation. Similarly, much information collected for these agencies and for the private sector, chiefly in compliance with local government ordinances, is contained in the files of private geotechnical consultants. As this information is identified and that which is useful in compiling hazards maps is collected, the second major task, interpretation and mapping, can proceed. Both information compilation and mapping are being carried out under two separate programs, one covering the entire state at a regional scale and one covering the Wasatch Front Counties at a more detailed scale.

Statewide Hazards Compilation

Statewide hazards compilation was initiated in October, 1985 with the goals of compiling a statewide computerized hazards bibliography and producing generalized hazards maps for the state at a scale of 1:750,000. The Hazards Section within the UGMS Applied Geology Program is carrying out this work. The hazards bibliography will include a comprehensive listing of all published and unpublished hazards information statewide. Information will be retrievable according to specific hazard, type of information, and geographic locality covered by each entry. When completed, the bibliography will be sorted geographically and printouts will be made available to various governmental entities (cities, counties, Associations of Governments) so that they will be aware of what data are available for their jurisdictions. In conjunction with the bibliography, UGMS will maintain a file for each 7 1/2-minute USGS quadrangle in the state which will include site-specific hazards reports (where appropriate), inventory sheets documenting report contents, and an index map with report locations plotted. For hazards information and reports covering larger areas (multiple quadrangles), smaller-scale index maps (1:500,000) will be used to show areas covered.

Using the data-base accumulated in the information collection phase of this program, a suite of user-oriented geologic hazard maps will be produced. At this time, maps depicting shallow ground water and flooding, slope failure hazards, earthquake hazards, and subsidence and problem soil foundation conditions are planned. Final map formats have not been determined, but these maps will give interpretations of relative hazard which can be used by local government planners in evaluating where hazards exist and where further study is necessary prior to development. Mapping and bibliography compilation are proceeding concurrently and are scheduled for completion in 1988.

Wasatch Front County Hazards Compilation

The second phase of the UGMS hazards compilation project is a cooperative effort with the USGS and five Wasatch Front Counties. The UGMS acquired funding under the USGS NEHRP to place geologists in Wasatch Front County governments for a period of three years, beginning in June, 1985 (see Wasatch Front County hazards geologists, Survey Notes, v. 19, no. 2, p. 10). Three geologists have been hired and placed in Weber-Davis Counties, Salt Lake County, and Utah-Juab Counties. The geologists are funded by the USGS, receive technical supervision and assistance from the UGMS, and are placed in each respective county planning department. Their goals are to: 1) collect all pertinent hazards information and develop a hazards library for each county, 2) utilize this information, supplemented with additional field studies as necessary, to compile hazards maps for each county, and 3) provide geological expertise to cities and counties to solve problems as needed during the course of the project. Libraries produced under this program are housed within the county planning department and will remain there at the conclusion of the project. Quadrangle files of site-specific hazards information will be maintained and index maps showing locations of hazards information will be compiled. The county geologists will compile basic geologic hazards maps showing depths to shallow ground water, slope failure hazards, faults and other earthquake hazards, and problem soil foundation materials at a scale of 1:24,000 for use within the planning department. Final hazards maps will be published at a probable scale of 1:100,000 by UGMS. In addition to providing a comprehensive library of data and hazard maps for each county, another goal is to demonstrate the usefulness of maintaining a geologist on the county staff as well as to establish effective working relationships between various levels of government concerning use of hazards information. The 3-year program will end in June, 1988, at which time it is hoped that the geologists will be retained by the counties as regular full-time staff.

Summary and Future Work

Completion of both UGMS hazards compilation efforts is scheduled for 1988. Interim results will be available prior to this time, and those with more immediate needs for hazards information are urged to contact UGMS. At the completion of this work, hazards information will be identified statewide, with detailed hazards mapping completed for Weber, Davis, Salt Lake, Utah, and eastern Juab Counties and regional hazards mapping completed for the remainder of the state. At that time, the emphasis of the UGMS Hazards Section will shift toward detailed hazards mapping in critical, populated areas throughout the state not already covered by the Wasatch Front County hazards geologists. The statewide hazards bibliography will be kept current as new information is collected, and updated printouts will be periodically made available to local governments and other users as appropriate. The UGMS is also presently reviewing existing city and county ordinances addressing geologic hazards and will prepare a report containing suggestions on how hazards may best be addressed by local government and how the information and maps produced under the UGMS hazards information compilation project can be used to implement such ordinances. Through these efforts, the UGMS continues to affirm its committment to advocating the consideration of geologic hazards early in the planning stages of development, with the ultimate goal of protecting the lives and property of this and future generations.

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Utah Earthquake Activity

January through March 1986

By ETHAN D. BROWN

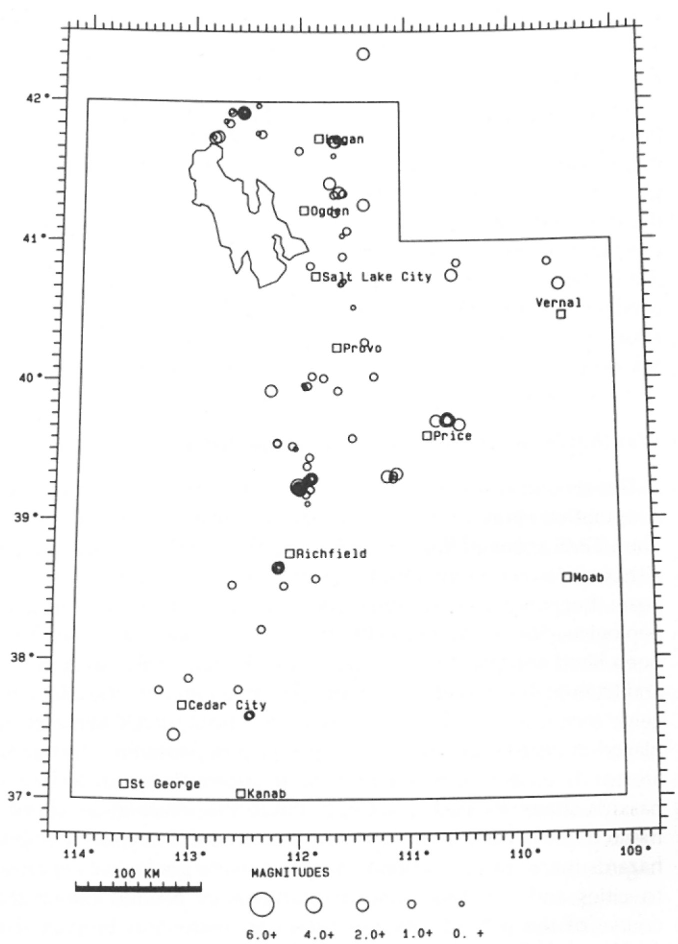
UNIVERSITY OF UTAH SEISMOGRAPH STATIONS
DEPARTMENT OF GEOLOGY AND GEOPHYSICS

THE University of Utah Seismograph Stations records an 80-station seismic network designed for local earthquake monitoring within Utah, southeast Idaho, and western Wyoming. During January 1 to March 30, 1986, 116 earthquakes were located within the Utah region. The epicenters shown in the seismograph map reflect typical earthquake activity scattered throughout Utah's main seismic region. The largest earthquake during this time period, M_L 4.4, occurred 6 miles southeast of Scipio, Utah on March 24. This earthquake, and a number of its aftershocks, were felt in the towns of Scipio, Fayette, Gunnison, and Centerfield. An event, M_L 3.3, was felt in Logan, Utah on January 13th and was located about 10 miles east of Logan.

There is a cluster of events in central Utah which includes the Scipio event and aftershocks. A group of earthquakes 10 km northeast of the mainshock occurred about one week before the mainshock (March 12 to March 18), although it is uncertain whether these events are foreshocks. Clusters of earthquakes ($M_L \leq 2.9$) in the vicinity of Price occur in areas of active underground coal mining. Clustering is typical for this area and has been observed in past reports.

A small earthquake of 30 M_L was recorded on April 30 centered 11 miles east of Manti.

Additional information on earthquakes within Utah is available from the University of Utah Seismograph Stations, Salt Lake City, Utah 84112 (telephone 801-581-6274).



GEOLOGIC PROJECTS IN UTAH

Conducted in Summer/1986

In 1985 a request form was sent to each graduate school of geology in the United States, asking for the location and a brief description of geologic mapping projects and other types of geologic studies planned for the summer of 1986 in Utah. The responses were reported and computerized, and are listed below. Included in this information are: 1) principal investigator; 2) school or organization; 3) county in which work was done; 4) specific geologic areas; 5) title of project; 6) type of study; and 7) scale of mapping. Over thirty-five schools, institutions and agencies responded to the questionnaire.

A new request form is included with this report for a description of projects planned for the summer of 1987. We would appreciate receiving your reply as soon as possible; this list will be printed in Survey Notes to provide information on geologic areas before the next field season starts. If you need more forms, please let us know.

Legend for Type of Study:

MP Geologic Mapping
EC Economic Geology
EV Environmental Geology
EG Engineering Geology
GC Geochemistry
GP Geophysics
HY Hydrology
MN Mineralogy
PL Paleontology Formation
QT Quaternary Soils
PT Petrology
VC Volcanology
SD Sedimentology
ST Structural Geology
SR Stratigraphy Formation

INVESTIGATOR	ORGANIZATION	COUNTY	LOCATION	TITLE	TYPE OF STUDY	SCALE OF MAP
ALMQUIST, C.	USBM	TOOELE	STANSBURY MOUNTAINS	NORTH STANSBURY MTNS. WILDERNESS STUDY AREA	EC	
ANDERS, D.E.	USGS	UINTAH	UINTA-PICEANCE BASIN	ORGANIC GEOCHEMISTRY OF LATE PALEOZOIC-TERT.	GC	
ANDERSON, J.J.	UGMS/USGS	IRON	LITTLE CREEK PEAK QUAD	GEOLOGIC MAP, LITTLE CREEK PEAK QUAD	MP	24000
ANDERSON, J.J.	UGMS/USGS	GARFIELD	PANGUITCH NW QUAD	GEOLOGIC MAP, PANGUITCH NW QUAD	MP	24000
ANDERSON, R.E.	USGS	WAYNE	CAPITOL REEF NATIONAL PARK	ANALYSIS OF LARAMIDE PALEOSTRESS, COLO. PLAT.	ST	
ANDERSON, R.E.	USGS	WASHINGTON	BULL VALLEY MTNS, CLOVER MTNS	LATE CENOZOIC STRUCTURAL HISTORY	MP	100000
ANDERSON, R.E.	USGS	SEVIER	SEVIER VALLEY	PALEOSTRESS ANALYSIS, CENTRAL SEVIER VALLEY	GP	
ANDERSON, R.E.	USGS		E. GREAT BASIN	REGIONAL-LOCAL HAZARDS, E. GREAT BASIN	EV	100000
AUBY, W.	UGMS/N. ILL. U.	JUAB	LEVAN QUAD	GEOLOGIC MAP, LEVAN QUAD	MP	24000
BAER, J.L.	BRIGHAM YOUNG U	WASHINGTON	BEAVER DAM WASH	RECON. GRAVITY, BEAVER DAM WASH	GP	100000
BAER, J.L.	BRIGHAM YOUNG U	SANPETE	SKINNER PEAK QUAD	GEOLOGIC MAP, SKINNER PEAK QUAD	MP	24000
BAER, J.L.	BRIGHAM YOUNG U	MILLARD	ESCALANTE DESERT	SUBSURFACE STRUCTURE, ESCALANTE DESERT	ST	100000
BAKER, V.R.	U. ARIZONA	GARFIELD	ESCALANTE RIVER, KANAB CREEK	PALEOHYDROLOGY HOLOCENE STRATIGRAPHY, S. UTAH	QT	
BANKS, R.L.	UGMS/N. ILL. U.	SANPETE	FOUNTAIN GREEN NORTH QUAD	GEOLOGIC MAP, FOUNTAIN GREEN NORTH QUAD	MP	24000
BARKER, D.S.	U. TEXAS AUSTIN	IRON	IRON SPRINGS DISTRICT	QTZ MONZONITE AND IRON DEPOSITS, IRON SPRINGS	GC	
BARTLEY, J.M.	UNIV. OF UTAH	BEAVER	MINERAL MOUNTAINS	STRUCTURAL GEOLOGY OF THE MINERAL MOUNTAINS	ST	24000
BARTON, H.N.	USGS		STATE WIDE	GEOCHEMICAL STUDY, BLM WILDNERNESS AREAS	GC	
BECKER, D.J.	S. METH. U.	BEAVER	MILFORD VALLEY, MINERAL MTNS	HYDROTHERMAL SYSTEM, MINERAL MTNS	HY	
BERRY, L.C.	UGMS/BYU	CACHE	PORCUPINE RESERVOIR QUAD	GEOLOGIC MAP, PORCUPINE RESERVOIR QUAD	MP	24000
BETANCOURT, J.L.	USGS	SAN JUAN	SE UTAH	LATE QUATERNARY PLANT ZONATION AND CLIMATE	QT	
BIEK, R.F.	UGMS/N. ILL. U.	JUAB	NEPHI QUAD	GEOLOGIC MAP, NEPHI QUAD	MP	24000
BOWMAN, J.R.	UNIV. OF UTAH	SALT LAKE	ALTA, WASATCH MOUNTAINS	METAMORPHISM AND SKARNS OF ALTA STOCK	GC	
BRANDT, C.J.	UGMS	GARFIELD	SOUTHERN UTAH	KAIPAROWITS BASIN PETROLEUM STUDY	EC	
BROWN, S.D.	USBM	MILLARD	WAH WAH MOUNTAINS	WAH WAH MTNS WILDERNESS STUDY AREA MIN. INV.	EC	
BROWNFIELD, M.E.	USGS	UINTAH	UINTA-PICEANCE BASIN	STRATIGRAPHY OF UPPER CRETACEOUS ROCKS	SR	
BUDDING, K.E.	UGMS	WASHINGTON	SW UTAH	GEOTHERMAL RESOURCES OF WASHINGTON COUNTY	HY	
CAPUTO, M.V.	U. CINCINNATI	SAN JUAN	SE UTAH	SED. CURTIS, SUMMERVILLE, MOAB TG. ENTRADA	SR	
CHATMAN, M.L.	USBM	GRAND	WESTWATER CANYON	BLACK RIDGE CYN AND WESTWATER CYN WILDERNESS	EC	
CHRISTENSON, G., AND OTHERS	UGMS		STATE WIDE	HAZARDS STUDIES IN UTAH	EV	
CHRISTIANSEN, E.H.	U. IOWA	JUAB	SHEEPROCK,THOMAS,SPOR MTNS.	IGNEOUS GEOCHEMISTRY, DEEP CREEK-TINTIC BELT	GC	24000
CIFELLI, R.L.	MUS. N. ARIZONA	KANE	KAIPAROWITS PLATEAU	VERTEBRATE PALEONTOLOGY, KAIPAROWITS PLATEAU	PL	
CLARK, D.L.	UGMS/N. ILL. U.	JUAB	JUAB QUAD	GEOLOGIC MAP, JUAB QUAD	MP	24000
CLARK, S.	U. ARIZONA	GARFIELD	ESCALANTE RIVER	COTTONWOOD CLUES TO FLOOD FREQUENCY	QT	
CLEM, K.	UGMS	DUCHESNE	UINTA BASIN	TERTIARY STRATIGRAPHY SW UINTA BASIN	SR	
CLEM, K.M.	UGMS	DUCHESNE	UINTA BASIN	UINTA BASIN PETROLEUM STUDY	EC	
CURREY, D.R.	U. UTAH	BOX ELDER	GREAT SALT LAKE DESERT	LATE HOLOCENE GREAT SALT LAKE LEVELS	QT	250000
DANA, G.F.	W. RES. INST.	UINTAH	UINTA BASIN	OIL SHALE AND TAR SAND, UINTA BASIN	EC	
DANA, G.F.	W. RES. INST.	WAYNE	UTAH CANYONLANDS	TAR SAND, TAR SAND TRIANGLE	EC	

INVESTIGATOR	ORGAN-IZATION	COUNTY	LOCATION	TITLE	TYPE OF STUDY	SCALE OF MAP
DAVIS, L.E.	WASH. STATE U.	TOOELE	N. UTAH AND SE IDAHO	PETROLOGY-CONODONT BIOSTRAT., WEST CANYON LS	SR	
DAVIS, O.K.	U. ARIZONA	GARFIELD	AQUARIUS PLATEAU	LATE QUATERNARY PALEOECOLOGY-CLIMATOLOGY	PL	
DICKERSON, R.	USBM	GRAND	WESTWATER CANYON	WESTWATER CANYON WILDERNESS STUDY AREA	EC	
DOELLING, H.H.	UGMS	GRAND	KLONDIKE BLUFFS QUAD	GEOLOGIC MAP, KLONDIKE BLUFFS QUAD	MP	24000
DOELLING, H.H.	UGMS	KANE	ELEPHANT BUTTE QUAD	GEOLOGIC MAP, ELEPHANT BUTTE QUAD	MP	24000
DOELLING, H.H.	UGMS	GRAND	THE WINDOWS SECTION QUAD	GEOLOGIC MAP, THE WINDOWS SECTION QUAD	MP	24000
DOELLING, H.H.	UGMS	GRAND	MOLLIE HOGANS QUAD	GEOLOGIC MAP, MOLLIE HOGANS QUAD	MP	24000
DOELLING, H.H.	UGMS	GRAND	MERRIMAC BUTTE QUAD	GEOLOGIC MAP, MERRIMAC BUTTE QUAD	MP	24000
DOELLING, H.H.	UGMS	KANE	RAINBOW POINT QUAD	GEOLOGIC MAP, RAINBOW POINT QUAD	MP	24000
DOELLING, H.H.	UGMS	KANE	CALICO PEAK QUAD	GEOLOGIC MAP, CALICO PEAK QUAD	MP	24000
DOELLING, H.H., DAVIS, F.D.	UGMS	GRAND	EASTERN UTAH	GEOLOGY OF GRAND COUNTY	MP	100000
DOELLING, H.H., DAVIS, F.D.	UGMS	KANE	SOUTH-CENTRAL UTAH	GEOLOGY OF KANE COUNTY	MP	100000
DOUGLASS, R.C.	USGS	BOX ELDER	PROMONTORY MTNS.	STRATIGRAPHY-FUSULINIDS, S. PROMONTORY MTNS.	PL	
ELSTON, D.P.	USGS	SALT LAKE	WASATCH MTNS.	MAGNETOSTRATIGRAPHY, BIG COTTONWOOD FM	SR	
ETHINGTON, R.L.	U. MO-COLUMBIA	MILLARD	HOUSE,CONFUSION RANGES	CONODONT BIOSTRATIGRAPHY, POGONIP GP	PL	
FIESINGER, D.W.	UTAH STATE UNIV	BOX ELDER	RHYOLITE MOUNTAINS	TERTIARY VOLCANIC ROCKS-RHYOLITE MTNS	PT	
FIESINGER, D.W.	UTAH STATE UNIV	BOX ELDER	CURLEW AND HANSEL VALLEYS	TERT. VOLCANIC ROCKS-CURLEW & HANSEL VALLEYS	PT	
FLEMING, R.W.	USGS	SANPETE	WASATCH PLATEAU	LANDSLIDES, WASATCH PLATEAU	EG	
FOUCH, T.D.	USGS	UINTAH	UINTA-PICEANCE BASIN	LATE PALEOZOIC TO PALEOGENE STRATIGRAPHY	SR	
FRANCZYK, K.J.	USGS		UINTA BASIN	STRATIGRAPHY-DEP. ENV., U.CRET.-L.TERT.	SD	
FRANCZYK, K.J.	USGS	UINTAH	SE UINTA BASIN	SEDIMENTOLOGY OF UPPER CRETACEOUS-PALEOGENE	SD	
GEISSMAN, J.W.	U. NEW MEXICO	BEAVER	MINERAL MTNS.	PALEOMAGNETISM, MINERAL MTNS.	GP	
GERNANT, R.E.	U. WISCONSIN	UINTAH	E. UINTA MTNS.	RIVER RUNNERS GUIDE TO DINOSAUR NATL. PARK	SR	
GOLDHABER, M.B.	USGS	UINTAH	UINTA-PICEANCE BASIN	SULFUR GEOCHEM. OF PALEOGENE OIL SHALE ROCKS	GC	
GOLDHABER, M.B., WANTY, R.B.	USGS	GARFIELD	S. HENRY MTN. BASIN	GEOCHEMISTRY HENRY BASIN V-U DEPOSITS	EC	
GRANGER, H.C.	USGS		COLORADO PLATEAU	U-V DEPOSITS, COLORADO PLATEAU	EC	
GRANT, S.K., PROCTOR, P.	U. MO-ROLLA	IRON	ANTELOPE HILLS	GEOLOGIC MAP, SILVER PEAK QUAD	MP	24000
GRANT, S.W.	HARVARD U.	DUCHESNE	UINTA BASIN	EOCENE OSTRACODA, GREEN RIVER FM	PL	
GRAUCH, T.J.S.	USGS	UINTAH	UINTA-PICEANCE BASIN	GRAVITY AND MAGNETIC COMPILATION AND INTERP.	GP	
GRIFFITTS, W.R.	USGS	IRON	S. WAH WAH MTNS	GEOLOGY AND RESOURCES, BERYLLIUM	EC	24000
GROUT, M.A.	USGS	UINTAH	UINTA-PICEANCE BASIN	FRACTURE AND STRESS HISTORY	ST	
HAIL, W.J., JR.	USGS	UINTAH	UINTA-PICEANCE BASIN	GEOLOGY OF OIL-SHALE ROCKS	MP	
HANLEY, J.H.	USGS		UINTA-PICEANCE BASINS	PALEONTOLOGY, MESOZOIC-CENOZOIC, UINTA BASIN	PL	
HANLEY, J.H.	USGS	UINTAH	UINTA-PICEANCE BASIN	MESOZOIC-CENOZIOC NON-MARINE MOLLUSKS	PL	
HARP, E.L.	USGS	SALT LAKE	WASATCH FRONT	SEISMIC SLOPE STABILITY, WASATCH FRONT AREA	EG	
HARRIGAN, B.J.	USBM	TOOELE	DEEP CREEK MOUNTAINS	DEEP CREEK MOUNTAINS WILDERNESS STUDY AREA	EC	600
HEYL, A.V., HASLER, J.W.	USGS	WASHINGTON	SILVER REEF DISTRICT	SILVER REEF SANDSTONE SILVER DEPOSITS	EC	
HINTZE, L.F., DAVIS, F.D.	UGMS	MILLARD	WESTERN UTAH	GEOLOGY OF MILLARD COUNTY	MP	100000
HINTZE, L.F., DAVIS, F.D.	UGMS	JUAB	WESTERN UTAH	GEOLOGY OF JUAB COUNTY	MP	100000
HOBBS, R.G.	USGS		E. UTAH	COALIZED METHANE	EC	
HULL, J.M.	RUTGERS U.	MORGAN	WASATCH MOUNTAINS	MICROSTRUCTURES OF MYLONITES, FARMINGTON CYN	ST	500
JENSEN, M.E.	UGMS	BOX ELDER	BRIGHAM CITY QUAD	GEOLOGIC MAP, BRIGHAM CITY QUAD	MP	24000
JENSEN, M.E.	UGMS	BOX ELDER	BEAR RIVER CITY QUAD	GEOLOGIC MAP, BEAR RIVER CITY QUAD	MP	24000
JEPSEN, K., NELSON, M.E.	FORT HAYS ST.U.	EMERY	EAST MOUNTAIN	PETROGRAPHY, STAR POINT SS AND BLACKHAWK FM	SR	
JOHNSON, R.C.	USGS	UINTAH	UINTA-PICEANCE BASIN	STRATIGRAPHY OF UPPER CRETACEOUS-PALEOGENE	SR	
KALISER, B.N.	UGMS		STATE-WIDE	LANDSLIDES/DEBRIS FLOWS OF UTAH	EG	
KEITH, A.C.	UGMS	WAYNE	HENRY MTNS.	HENRY MTNS. COAL FOLIO	EC	100000
KEITH, A.C.	UGMS		STATE WIDE	UTAH COAL RESOURCES DATA SYSTEM	EC	
KEITH, A.C.	UGMS		STATE WIDE	UTAH COAL SAMPLING	EC	
KERNS, R.L.	UGMS		WESTERN UTAH	GREAT BASIN AND HINGELINE PETROLEUM STUDIES	EC	
KING, K.W.	USGS	SALT LAKE	N. UTAH	STRONG MOTION NETWORK, GROUND RESPONSE	GP	
KIRSCHBAUM, M.A.	USGS	UINTAH	WASATCH PLATEAU	STRATIGRAPHY OF CRETACEOUS-PALEOGENE STRATA	SR	
KNESS, R.	USBM	GARFIELD	CIRCLE CLIFFS	STEEP CREEK WILDERNESS STUDY AREA	EC	
KORZEB, S.	USBM	JUAB	FISH SPRINGS RANGE	MINERAL INVESTIGATION WILDERNESS STUDY AREA	EC	

INVESTIGATOR	ORGAN-IZATION	COUNTY	LOCATION	TITLE	TYPE OF STUDY	SCALE OF MAP
KRANTZ, B.	U. ARIZONA	EMERY	SAN RAFAEL SWELL	ANALYSIS OF FAULTING, SAN RAFAEL SWELL	ST	
KRANTZ, B., DAVIS, G.	U. ARIZONA	KANE	PAUNSAUGUNT PLATEAU	REGIONAL FAULT PATTERNS, PAUNSAUGUNT PLATEAU	ST	
KREIDLER, T.J.	USBM	WASHINGTON	CANAAN MOUNTAIN	MINERAL INVESTIGATION WILDERNESS STUDY AREA	EC	
LANE, M., CORBETTA, P.	USBM	KANE	ESCALANTE CANYON	MINERAL RESOURCES WILDERNESS STUDY AREA	EC	
LARSEN, B.R.	U. UTAH	MILLARD	CONFUSION RANGE	STRATIGRAPHY-PALEOENVIRONMENT, U.GUILMETTE FM	SR	
LAWTON, T.F.	SOHIO PETR. CO.		CENTRAL UTAH	TECTONIC-SED. EVOLUTION, UTAH FORELAND BASIN	SD	
LOWE, M.V.	UGMS/UTAH ST. U	CACHE	SMITHFIELD QUAD	GEOLOGIC MAP, SMITHFIELD QUAD	MP	24000
LUND, W.R.	UGMS		STATE-WIDE	ENGINEERING GEOLOGY CASE STUDIES IN UTAH	EG	
LUND, W.R.	UGMS		STATE-SIDE	TECHNICAL REPORTS FOR SITE INVESTIGATIONS	EV	
LUNDBY, W.	USBM	MILLARD	HOUSE RANGE	NOTCH PEAK WILDERNESS STUDY AREA	EC	
MACHETTE, M.N.	USGS	UTAH	S. WASATCH FRONT	URBAN HAZARDS, WASATCH FRONT	EV	
MARZOLF, J.E.	S. ILLINOIS U.	KANE	SW UTAH	U. TRIASSIC-L. JURASSIC, SW UTAH	SD	
MATTOX, S.	UGMS/N. ILL. U.	SANPETE	HELLS KITCHEN CANYON SE QUAD	GEOLOGIC MAP, HELLS KITCHEN CANYON SE QUAD	MP	24000
MAUGHAN, E.K.	USGS		STATE WIDE	PALEOGEOGRAPHY OF PETROLEUM ROCKS	EC	
MCDERMOTT, J.G.	UGMS/N. ILL. U.	JUAB	CHRISS CANYON QUAD	GEOLOGIC MAP, CHRISS CANYON QUAD	MP	24000
MILLER ,D.M.	USGS	TOOELE	SILVER ISLAND MTN	GEOLOGIC MAP, GRAHAM PEAK QUAD	MP	24000
MILLER, D.M.	USGS	BOX ELDER	NW UTAH	TECTONICS, NW UTAH	MP	100000
MILLER, D.M.	USGS	BOX ELDER	SILVER ISLAND MTNS	GEOLOGIC MAP, JACKSON QUAD	MP	24000
MILLER, D.M.	USGS	TOOELE	SILVER ISLAND MTN	GEOLOGIC MAP, MINERS CANYON QUAD	MP	24000
MILLER, D.M.	USGS	BOX ELDER	SILVER ISLAND MTN	GEOLOGIC MAP, CRATER ISLAND QUAD	MP	24000
MILLER, D.M.	USGS	BOX ELDER	SILVER ISLAND MTNS	GEOLOGIC MAP, LUCIN 4 NW QUAD	MP	24000
MILLER, D.M.	USGS	BOX ELDER	SILVER ISLAND MTN	GEOLOGIC MAP, PIGEON MOUNTAIN QUAD	MP	24000
MILLER, D.M.	USGS	TOOELE	SILVER ISLAND MTN	GEOLOGIC MAP, TETZLAFF PEAK QUAD	MP	24000
MILLER, D.M.	USGS	BOX ELDER	SILVER ISLAND MTN	GEOLOGIC MAP, LEMAY ISLAND QUAD	MP	24000
MILLER, E., GANS, P.	STANFORD U.	JUAB	DEEP CREEK, CONFUSION RANGES	GEOLOGIC MAPS, STRUCTURE, AND GEOCHRONOLOGY	MP	24000
MOLNAR, P.	MIT	BOX ELDER	HANSEL VALLEY	MICROEARTHQUAKES, N. UTAH,	GP	
MORK, A.	UGMS/E. WASH. U	CACHE	BOULDER MOUNTAIN QUAD	GEOLOGIC MAP, BOULDER MOUNTAIN QUAD	MP	24000
MORRIS, H.T.	USGS	JUAB	DELTA 1X2 DEGREE QUAD.	DELTA CUSMAP, TINTIC DISTRICT	MP	250000
NABELEK, P.I.	U. MO-COLUMBIA	MILLARD	HOUSE RANGE	PETROGENESIS NOTCH PEAK COMPLEX	PT	
NELSON, M.E., AND OTHERS	FORT HAYS ST.U.	EMERY	SAN RAFAEL SWELL	STRATIGRAPHY, CEDAR MTN-MORRISON FMS	SR	
NELSON, M.E., MADSEN, J.H.	FORT HAYS ST.U.	DUCHESNE	UINTA BASIN	VERTEBRATE PALEOLTOLOGY, UINTA FM	PL	
NELSON, M.E., MADSEN, J.H.	FORT HAYS ST.U.	DAVIS	WASATCH FRONT	VERTEBRATE PALEONTOLOGY, LAKE BONNEVILLE BEDS	PL	
NELSON, M.E., MADSEN, J.H.	FORT HAYS ST.U.	EMERY	SAN RAFAEL SWELL	VERTEBRATE PALEONTOLOGY, CEDAR MTN. FM	PL	
NELSON, M.E., MADSEN, J.H.	FORT HAYS ST.U.	TOOELE	NW DEEP CREEK MTNS.	VERTEBRATE PALEONTOLOGY, MIOCENE W. UTAH	PL	
NELSON, S.T.	BRIGHAM YOUNG U	SEVIER	GEYSER PEAK QUAD	GEOLOGIC MAP, GEYSER PEAK QUAD	MP	24000
NEUBERT, J.	USBM	GARFIELD	HENRY MOUNTAINS	BULL MTN AND MT HILLERS WILDERNESS STUDY AREA	EC	
NICHOLS, D.J.	USGS	UINTAH	UINTA-PICEANCE BASIN	PALYNOLOGY OF UPPER CRETACEOUS-PALEOGENE	PL	
NICHOLS, K.M.	USGS		CENTRAL AND NORTHERN UTAH	SEDIMENTOLOGY OF MISSISSIPPIAN CARBONATES	SD	
NIELSON, R.L.	S.F.AUSTIN U.	UTAH	CENTRAL WASATCH MTNS.	STRATIGRAPHY, DEPOSITIONAL ENV., KIRKMAN FM	SR	
NIELSON, R.L.	S.F.AUSTIN U.	KANE	SOUTH-CENTRAL UTAH	STRATIGRAPHY DEPOSTIONAL ENV., KIABAB FM	SR	
NUCCIO, V.F.	USGS	UINTAH	UINTA-PICEANCE BASIN	THERMAL MATURITY, VITRINITE REFLECTANCE	GC	
OBRADOVICH, J.D.	USGS		STATE WIDE	GEOCHRONOLOGY, JURASSIC STRATA OF UTAH	SR	
OLESON, N.E.	BAYLOR U.	DUCHESNE	UINTA BASIN	PETROLEUM GEOLOGY EOCENE L.GREEN RIVER FM	SR	
OVAITT, G.C.	UGMS/KANSAS ST.	MILLARD	GREAT BASIN	QUATERNARY DEPOSITS, SEVIER LAKE REGION	QT	
OWEN, C.	U.UTAH	KANE	COLORADO PLATEAU	MINERALOGY OF BURNED COAL ZONES	MN	
PAULL, R.K.	U. WISCONSIN		STATE WIDE	CONODONT BIOSTRATIGRAPHY, L. TRIASSIC	PL	
PERRY, W.J., JR.	USGS	UINTAH	UINTA-PICEANCE BASIN	STRUCTURAL GEOLOGY OF THE PICEANCE BASIN	ST	
PERSONIUS, S.	USGS	BOX ELDER	N. WASATCH FRONT	QUATERNARY FAULTING, N. WASATCH FAULT ZONE	ST	50000
PETERSON, F.	USGS		COLORADO PLATEAU	BASIN ANALYSIS, JURASSIC OF COLORADO PLATEAU	SD	
PHILLIPS, F.	NEW MEX. TECH.	BOX ELDER	GREAT SALT LAKE	DATING SEDIMENTARY HALITE, GREAT SALT LAKE	QT	
PITMAN, J.K.	USGS	DUCHESNE	UINTA BASIN	DIAGENESIS TERTIARY-CRETACEOUS, UINTA BASIN	GC	
PITMAN, J.K.	USGS	UINTAH	UINTA-PICEANCE BASIN	PETROLOGY OF UPPER CRETACEOUS-PALEOGENE ROCKS	PT	
POOLE, F.G.	USGS		GREAT BASIN AND N. ROCKIES	METALIFEROUS BLACK SHALES	EC	
POWERS, R.B.	USGS	SUMMIT	N. ROCKIES	ABSOROKA THRUST EXPLORATION	EC	

INVESTIGATOR	ORGAN-IZATION	COUNTY	LOCATION	TITLE	TYPE OF STUDY	SCALE OF MAP
PROCTOR, P.D.	UGMS/BYU	IRON	ANTELOPE PEAK QUAD	GEOLOGIC MAP, ANTELOPE PEAK QUAD	MP	24000
PROTHERO, D.R.	OCCIDENTAL COLL	DUCHESNE	UINTA BASIN	MAGNETOSTRATIGRAPHY UINTA AND DUCHESNE R. FMS	GP	
RAUP, O.B.	USGS	GRAND	PARADOX BASIN	PETROLOGY-GEOCHEMISTRY, MARINE EVAPORITES	SD	
REYNOLDS, R.L.	USGS	SAN JUAN	LIBSON VALLEY	PALEOMAGNETIC-PETROLOGIC STUDY, CUTLER FM	EC	
RICE, K., MCCALPIN, J.	UTAH STATE U.	CACHE	MANTUA VALLEY	HYDROLOGY MANTUA VALLEY	HY	24000
RIGBY, J.K.	BRIGHAM YOUNG U	CARBON	N. WASATCH PLATEAU	GEOL. MAPS SCOFIELD RES.,COLTON,KYUNE QUADS	MP	24000
RIGBY, J.K.	BRIGHAM YOUNG U	MILLARD	HOUSE RANGE	CAMBRIAN PALEONTOLOGY, MARJUM-WHEELER FMS	PL	
RIGBY, J.K.	BRIGHAM YOUNG U	GARFIELD	CAPITOL REEF NATL. PARK	JURASSIC FMS, CAPITOL REEF	SR	
RIGBY, J.K.	BRIGHAM YOUNG U	EMERY	SAN RAFAEL SWELL	TRIASSIC-JURASSIC, E. SAN RAFAEL SWELL	SR	
RIGBY, J.K.	BRIGHAM YOUNG U	WASHINGTON	BEAVER DAM MTNS.	TRIASSIC-JURASSIC FMS, BEAVER DAM MTNS.	SR	
ROBISON, S.F.	BRIGHAM YOUNG U	SANPETE	WASATCH PLATEAU	PALEOCENE VERTEBRATES, NORTH HORN FM.	PL	
ROBISON, S.F.	US FOREST SER.	EMERY	SAN RAFAEL SWELL	E. CRETACEOUS VERTEBRATE FAUNA, CEDAR MTN FM	PL	
ROBISON, S.F.	US FOREST SER.	EMERY	WASATCH PLATEAU	FAUNA/FLORA BLACKHAWK FM	PL	
ROGERS, A.M.	USGS		N. UTAH	SITE GEOLOGY EFFECTS ON GROUND SHAKING, UTAH	GP	
ROWLEY, P.D.	USGS	BEAVER	RICHFIELD 1X2 QUAD	GEOLOGY RICHFIELD 1X2 QUAD	MP	24000
ROWLEY, P.D.	UGMS/USGS	SEVIER	ANTELOPE RANGE QUAD	GEOLOGIC MAP, ANTELOPE RANGE QUAD	MP	24000
ROWLEY, P.D.	UGMS/USGS	PIUTE	MARYSVALE QUAD	GEOLOGIC MAP, MARYSVALE QUAD	MP	24000
SABLE, E.G., SANCHEZ, J.D.	USGS	KANE	MARKAGUNT, PAUNSAUGUNT PLATS.	KAIPAROWITS BASIN FRAMEWORK	EC	100000
SANDO, W.J.	USGS		GREAT BASIN	CORAL BIOSTRATIGRAPHY, MISSISSIPPIAN, W.US	PL	
SARGENT, K.A.	USGS		GREAT BASIN	PLANNING-COORDINATION RADWASTE, BASIN&RANGE	EG	
SAWATZKY, D.L.	USGS	UINTAH	UINTA-PICEANCE BASIN	REMOTE SENSING AND LINEAMENT ANALYSIS	ST	
SCHLIPP, W., GERNANT, R.E.	U. WISCONSIN	SAN JUAN	UTAH CANYONLANDS	PALEOENVIRONMENTS, ELEPHANT CANYON FM-PERMIAN	SD	
SCHREINER, R.A.	USBM	SAN JUAN	BUTLER WASH, BRIDGER JACK MESA	MINERAL RESOURCES WILDERNESS STUDY AREA	EC	
SCOTT, R.W.	USGS	UINTAH	UINTA BASIN	GEOLOGIC MAP, WOLF POINT QUAD	MP	24000
SHUBAT, M.A.	UGMS	IRON	ANTELOPE RANGE	ANTELOPE RANGE MINING DISTRICT STUDY	EC	
SHUBAT, M.A., SIDERS, M.A.	UGMS	IRON	SILVER PEAK QUAD	GEOLOGIC MAP, SILVER PEAK QUAD	MP	24000
SIDERS, M.A.	UGMS	IRON	MOUNT ESCALANTE QUAD	GEOLOGIC MAP, MOUNT ESCALANTE QUAD	MP	24000
SMITH, R.K.	U.TEXAS S. ANT.	SALT LAKE	WASATCH MTNS.	PLAGIOCLASE ZONING, LITTLE COTTONWOOD STOCK	MN	
STEVEN, T.A.	USGS	BEAVER	RICHFIELD 1X2 QUAD.	GEOLOGY RICHFIELD 1X2 QUAD.	GC	
STOVER, C.W.	USGS		STATE WIDE	UNITED STATES EARTHQUAKES	GP	
STURM, P.A.	UGMS		GREAT SALT LAKE	GREAT SALT LAKE BRINES RESEARCH	EC	
SWAIN, F.M.	U. DELAWARE	BOX ELDER	GREAT BASIN	CENOZOIC FRESHWATER OSTRACODA, GREAT BASIN	PL	
TAYLOR, M.E.	USGS	MILLARD	GREAT BASIN	U. CAMB.-L. ORD., PALEONTOLOGY-DEP. ENVIR.	PL	
TAYLOR, M.E.	USGS		NW UTAH	E.PALEOZOIC SEDIMENTATION, TOOELE ARCH	SD	
THOMPSON, J.R.	USBM	SAN JUAN	CANYONLANDS	INDIAN CREEK/BEHIND ROCKS WILDERNESS ST. AREA	EC	
TOOKER, E.W.	USGS	SALT LAKE	OQUIRRH MOUNTAINS	GEOLOGIC MAPS, OQUIRRH MTNS	MP	24000
TUESINK, M.F.	N.ARIZ.U./USGS	WASHINGTON	SW UTAH	ERG MARGIN SEDIMENTOLOGY, KAYENTA-NAVAJO FMS	SD	
TUFTIN, S.	USBM	MILLARD	HOWELL PEAK, SWASEY MOUNTAIN	MINERAL INVESTIGATION WILDERNESS STUDY AREA	EC	
TURNER, R.L.	USGS		COLORADO PLATEAU	GEOCHEMISTRY, BLM WILDERNESS AREAS	GC	
TURNER-PETERSON, C.E.	USGS		SAN JUAN BASIN	SEDIMENTOLOGY-URANIUM, MORRISON FM	SD	
TUTTLE, M.L.	USGS	UINTAH	UINTA-PICEANCE BASIN	SULFUR GEOCHEMISTRY OF OIL-SHALE ROCKS	GC	
VERBEEK, E.R.	USGS	UINTAH	UINTA-PICEANCE BASIN	FRACTURE AND STRESS HISTORY	ST	
WANTY, R.B.	USGS	UINTAH	UINTA-PICEANCE BASIN	GEOCHEMICAL AND PALEO-HYDROTHERMAL STUDY	GC	
WEAVER, C.E., PADAN, A.	GEORGIA TECH.	SAN JUAN	PARADOX BASIN	CLAY-SALT MINERALOGY, GIBSON DOME #1	GC	
WEBB, R.H.	USGS/U. ARIZONA	KANE	ESCALANTE RIVER	LATE HOLOCENE FLOODING, ESCALANTE RIVER	EV	
WEBSTER, G.D.	WASH. STATE. U.	BOX ELDER	N. UTAH	MISSISSIPPIAN CRINOIDS, N. UTAH	PL	
WEISS, M.P.	N. ILLINOIS U.	CARBON	SW UINTA BASIN	GEOLOGY AND STRATIGRAPHY OF SW UINTA BASIN	MP	100000
WILLIS, G.C.	UGMS	SEVIER	AURORA QUAD	GEOLOGIC MAP, AURORA QUAD	MP	24000
WILLIS, G.C.	UGMS	SANPETE	REDMOND CANYON QUAD	GEOLOGIC MAP, REDMOND CANYON QUAD	MP	24000
WITKIND, I.J.	USGS	EMERY	PRICE 1X2 QUAD	GEOLOGIC MAP, CENTRAL UTAH ENERGY LANDS	MP	100000
WITTING, K.K., AND OTHERS	U. CALIF. DAVIS	GRAND	UPPER COLORADO RIVER	RELATION OF SALINITY TO LANDFORMS, GEOL. FMS.	QT	
WOOD, R.H.	USBM	WASHINGTON	GUNLOCK, ST. GEORGE	COTTONWOOD CYN/RED MTN WILDERNESS STUDY AREAS	EC	
ZELTEN, J.	USBM	KANE	ZION NATIONAL PARK AREA	ORDERVILLE CANYON AREA WILDERNESS STUDY AREAS	EC	
ZIMBELMAN, D.	USGS	MILLARD	DELTA 1X2 QUAD.	TRACE-ELEMENT GEOCHEMISTRY, DELTA 1X2 QUAD.	GC	

UGMS Workshop on Landslide Inventories

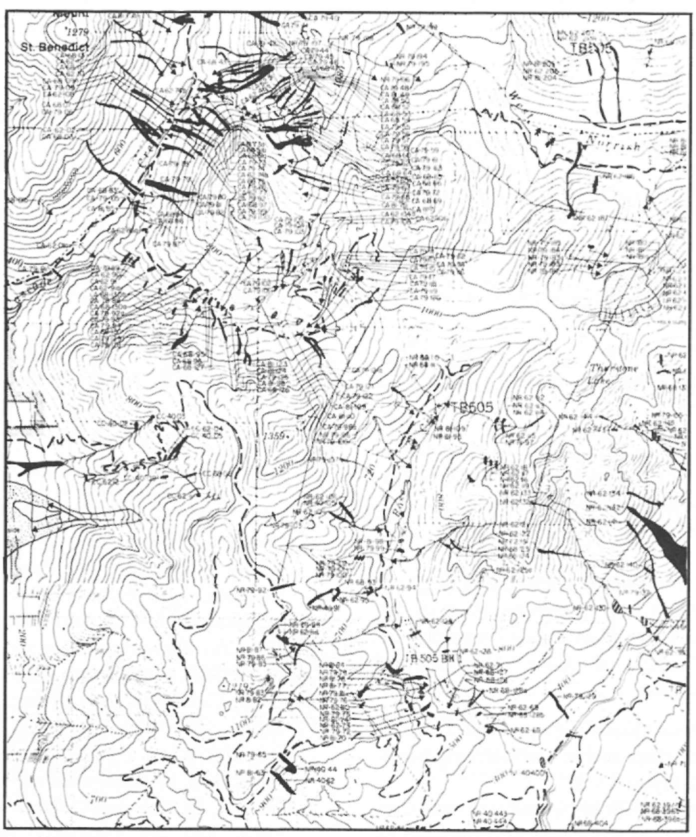
by Sandra N. Eldredge

VIRTUALLY every year, somewhere in the nation, landslides disrupt transportation routes, utilities, facilities, homes, and fish habitat in streams, resulting in resource conflicts, injury to life, and high costs in damage and repair. In response to this problem, landslide inventories have become a widely-used procedure to document landslides and assess the potential for these slope movements. They are used to define the problems, assess the geographic extent of the hazard, develop techniques and policies to reduce landslide losses, and to plan and manage land use.

Landslide inventories have been performed nation-wide at the state, county, and urban levels, as well as in several other countries. The inventories differ in purpose, methodologies used, and in their products.

In 1985 UGMS received a commitment of two years' funding from the U.S. Geological Survey for landslide inventory work. We became interested in the types of inventories which have been or are being performed, the various methodologies used, and what has worked or not worked elsewhere. As an initial part of this project, samples of inventories from other areas were compiled. More than 40 individuals were contacted from other state geological surveys, universities, federal agencies, and Canada in an attempt to get a representative sampling of inventories. This study was intended to help Utah develop a standard form and user manual for our landslide inventory (see article, p. 3).

Concurrently, the NAS/NAE landslide subcommittee of the Committee on Ground Failure Research, of which Genevieve Atwood is a member, has wanted to address the question, "Are new techniques and more research needed in order to inventory landslides successfully or inventory them better?" To discuss these three issues, (1) what types of inventories are there, what are their purposes, uses, methodologies, weaknesses and strengths; (2) is more research needed; and (3) the development of a standard form and manual for Utah, a workshop was held at the UGMS March 6-7. Eighteen individuals from state geologic surveys, U.S. Geological Survey, U.S. Forest Service, Utah universities, and the landslide subcommittee of the NAS/NAE Committee on Ground Failure Research attended the workshop.



Part of Norrish-Cascade landslide inventory map, Victoria, British Columbia.

The objectives of landslide inventories can be grouped into four general areas: (1) to increase public awareness; (2) to use for land-use planning by planners, developers, foresters, engineers, managers, realtors, etc.; (3) to develop susceptibility or risk maps; and (4) to use as a data base documenting geomorphic processes. While the objectives often determine the map scale to be used, the methodologies and techniques used are in turn dependent on the map scale.

The small-scale maps for landslide inventory purposes are those that cover states or entire countries (1:250,000 to 1:2,500,000). Most state-wide inventories have been produced at the 1:500,000 scale as a result of cooperatives with the USGS for a national inventory. Maps at this scale greatly enhance public awareness of landslides. In addition to the 1:500,000 scale maps, several states produce larger scale maps showing more detailed work in special areas.

Intermediate scale maps are smaller than 1:24,000 and include 1:48,000, 1:50,000, 1:62,500, and 1:100,000 as common scales and are used for inventorying counties or urban areas. They increase public awareness and are designed to be used by local governments for general planning purposes.

The large-scale landslide maps are 1:24,000 and larger. This scale is most often used by the USFS and preferred by many planners. It is a popular scale since good topographic base maps are available from the U.S. Geological Survey. The objectives at this scale are to develop landslide susceptibility and hazard maps, and to form a better understanding of landslide processes. These scales, where they exist, become the basis for the smaller scale inventories.

In order to produce these inventories, geologists commonly use aerial photographs, compilations of existing information (e.g., geologic maps, slope maps, Soil Conservation Service data), then transfer the information to topographic quadrangle maps and field check the landslides. Other methods that can be used include literature searches; collection of meteorological, hydrological, soils, vegetative, geophysical subsurface and surface data; FEMA storm reports; monitoring; field sampling; laboratory work; sending out questionnaires to various agencies and universities; utilizing standard report forms; remote sensing; and air overflights.

In addressing the question if more research is needed, the group discussed new methodologies and research that could make inventories easier to do, more comprehensive, more accurate, and more helpful to users. It was agreed that more and better inventory work is needed, and that more research would help achieve these goals. Much of the work that needs to be done is the application of known technologies as well as the development of new technologies. In focusing on the need for new techniques or areas where research could make a significant contribution to increase the effectiveness of landslide inventories, four areas need attention and creative ideas.

First there is a need for better techniques to recognize and classify landslides that are presently difficult to recognize. This includes more complete recognition of debris flow scarps and deposits, identification of small landslides, of landslides in heavily vegetated terrain, and better techniques for recognizing older landslides.

The second area that appears to be evolving rapidly and needs continued support and generation of ideas is the application of computer techniques to landslide indentification, information display, and susceptibility maps. Investment in digitizing techniques and computer analysis appears to be the most promising type of research now for doing landslide inventories better, faster, and differently. Technology exists which has not yet been applied specifically to landslide terrain identification and has potential to automatically map certain landslides, distinguish terrains, and classify hillside areas into landslide habitats.

New techniques are needed for dating the ages of landslide movements. Dating techniques appear experimental and might prove highly effective although the existing techniques for tree ring analysis, paleovegetation analysis, carbon dating, and others have not been fully successful. This research could also address the need for identifying present activity of slow moving landslides and the understanding of rates of processes.

Finally, there is a need for innovative ways to transfer the landslide inventory information to the user. The user is often not a geologist, but a planner, developer, or engineer. Several of the individuals whose inventories were surveyed expressed concern that either their product was being misused or not used at all. One of the problems encountered is the terminology used by the geologists. A standardized terminology, if it were done from the users' perspective, would greatly help in the translation efforts. It was suggested that two definitions be presented in the inventory's legend or accompanying manual, one for geologists and one for non-geologists.

Another aspect of transferring information is the continued need for the exchange of information within the scientific community. This includes taking advantage of opportunities to transfer technological advances made by federal agencies to their state and academic counterparts. Also of importance is the continued exchange of technical information and developments with other countries.

Other areas of research and development might have potential for improving the effectiveness of landslide inventories, such as geophysical techniques and soil classification information. Hopefully, such techniques will be developed but their potential for success is not as assured as it is for use and development of computer technologies, ways to better recognize landslides that are presently difficult to recognize, and creative approaches to transfer information to the users.

Techniques and methodologies presently exist for a large variety of inventories, however, many individuals who have performed these inventories have expressed a desire for more efficient landslide inventories and methodologies. Research techniques could make inventory work easier, faster, better, more accurate and more helpful. ■

UGMS STAFF CHANGES

The following staff changes have taken place since the last issue:

Kim Bernhardt is the new drafting technician in Editorial.

Cory Burt has joined the staff as a computer programmer.

Gary Christenson is the section chief for the newly organized Hazards Compilation Section.

Sandy Eldredge has left the UGMS for the lure of Alaska.

NEW PUBLICATIONS

Maps

Map 79, *Provisional Geologic Map of the Limekiln Knoll Quadrangle, Box Elder County, Utah,* by Brandon E. Murphy, Stanley S. Beus, and Charles G. Oviatt, 2 sheets, 9-page booklet, scale 1:24,000. Price: $3.75*.

Located in North central Utah, immediately south of the Utah-Idaho state line, including the West Hills, a continuation of the Promontory Mountains north of Great Salt Lake. Outcrops include Paleozoic sediments, the Tertiary Salt Lake Formation, and unconsolidated Quaternary sediments.

Map 83, *Geologic Map of the Salina Quadrangle, Sevier County, Utah,* by Grant C. Willis, full-color map and accompanying booklet, 20 p., 2 plates, scale 1:24,000. Price: $5.00*.

Located in Central Utah northeast of Richfield. Jurassic and Cretaceous rocks have nearly vertical dips truncated and overlain by nearly flat-lying Tertiary volcanic rocks. Mineral resources include gypsum, salt, limestone, calcite and clay, minor lead-zinc deposits, and thin coal outcrop in Salina Canyon.

Map 84, *Geologic Map of the Pinon Point Quadrangle, Iron County, Utah,* by Mary A. Siders, 1986, 2 sheets, 4-color, 12-page report, scale 1:24,000. Price: $5.00*.

Located in Southwestern Iron County on the edge of the Escalante Desert. Central and southern part of quadrangle is dominated by Oligocene and Miocene volcanic rocks. To the north, the volcanics are buried under Quaternary alluvial deposits. The quadrangle lies on the Delamar-Iron Springs Mineral Belt but contains no known occurrences or geothermal resource. The Escalante Silver Mine lies to the east of the mapped area.

Map 85, *Geologic Map of Beryl Junction Quadrangle, Iron County, Utah,* by Mary A. Siders, full-color map and accompanying booklet, 11 p., 2 plates, scale 1:24,000. Price: $5.00*.

Located in southwestern Utah, on the edge of the Escalante Desert. In the west, volcanic rocks of Oligocene through Miocene age are exposed. Northeast-trending epithermal veins within the volcanic rocks contain silver mineralization. The eastern two-thirds of the quadrangle is covered by unconsolidated Quaternary alluvium.

Map 89, *Provisional Geologic Map of the Sego Canyon Quadrangle, Grand County, Utah,* by Grant C. Willis, 1986, full-color map and accompanying booklet, 14 p. 2 plates, scale 1:24,000. Price: $5.00*.

Located along the southern face of the Book Cliffs in Grand County, Utah. Contains an estimated 205 million tons of coal in mineable seams. Structures similar to those producing oil and gas in adjacent areas may underlie the Sego Canyon quadrangle. Other resources include sand and gravel.

Bulletins

Reprint of Bulletin 83, *Mineralization in the Gold Hill Mining District, Tooele County, Utah,* by H.M. El-Shatoury and J.A. Whelan, 37 p., 3 plates. Price: $3.50*.

Bulletin 121, *Annotated Geothermal Bibliography of Utah,* by Karin E. Budding and Miriam H. Bugden, compilers, 82 pages. Price: $5.00*.

Annotated list of references by author pertaining to geothermal resources in Utah, plus a list of all government-funded geothermal developments in the state from 1966 through 1984 by area providing a summary of work accomplished. A map showing the locations of the geothermal areas of Utah, listing those which were active in 1985. References are indexed geographically by region, county, and geothermal area.

Open File Reports

Open File Report 86, *Farmington Bay Project Report,* by Paul A. Sturm, 1986, 56 pages, maps and tables. Price: $3.00*.

In 1980 a proposal was made to make this southeast bay of the Great Salt Lake into a freshwater reservoir. A cooperative study was done by Division of Water Pollution Control, the Division of Water Resources, Utah State University and the UGMS.

Open File Report 87, *Utah Geological and Mineral Survey Brine Sampling Program, 1966-1985, Data Base and Averaged Data,* by Paul A. Sturm, 1986, 188 pages, maps, tables, analytical data. Price: $9.00*.

Brine samples are analyzed for potassium, sodium, magnesium, calcium, chloride, sulfate, bromide, boron and lithium ions and for specific gravity. Nearly 5,400 samples have been taken and analyzed in the past 20 years; these are stored on the UGMS computer for retrieval and manipulation. This basic monthly and averaged data is presented as a printout example.

Open File Report 88, *Utah Coal Methane Desorption Project Final Report,* by Archie Smith, 59 p. Price: $3.50*.

UGMS collected and examined petrographically 152 coal samples from Utah coal fields for determination of methane.

Reports of Investigation

Report of Investigation 205, *Description, Correlation, and Summary of Coal Drill Core TM-7,* by D.A. Foster and S.N. Sommer, 30 p. Price: $3.50*.

Coal Drill Core TM-7 was drilled in Trail Mountain, Emery County, Utah. Description, photographs and summary of this nearly complete section of core through the coal-bearing Blackhawk Formation.

Report of Investigation 206, *Geologic Evaluation of a Proposed Wastewater Treatment Plant Site, Washington County, Utah,* by William Lund, 22 p. Price: $3.15*.

A geologic evaluation was made of the 480-acre site proposed for a regional wastewater treatment plant southwest of St. George in Washington County, Utah.

Report of Investigation 208, *Technical Reports for 1985, Site Investigation Section,* compiled by W. Mulvey. Price: $9.00*.

A set of 39 short papers reporting site-specific investigations from all over the state.

Report of Investigation 210, *Overburden Map and Thickness Determinations, Sunnyside Oil-impregnated Sandstone Deposit, Carbon and Duchesne Counties, Utah,* by J. Wallace Gwynn, 7 p., 1 plate. Price: $2.45*.

The Sunnyside oil-impregnated sandstone (tarsand) deposits lie in Carbon and Duchesne counties. The thickness of the overburden and the tarsands have been determined from logs, core holes, measured sections, and data presented in UGMS RI 196.

Report of Investigation 211, *An Approximation of the Physical and Chemical Characteristics of Farmington Bay and Bear River Bay, Great Salt Lake, Utah,* by J. Wallace Gwynn, 20 p. Price: $2.80*.

Farmington Bay and Bear River Bay have been separated from the main south arm of Great Salt Lake by causeways. This study compares the salinity of the bays with the Great Salt Lake brine, and explores the distribution of salinity, movement of brines, and changes of salt content within the bays.

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The UGMS primary purpose is to provide geologic information about the state of Utah to a variety of users. Survey Notes is our way of reaching out to interested citizens and decision makers in language that both geologists and non-geologists can understand. We do this as part of our mission to inform the public as well as professional geologists about Utah's many mineral, energy, and other geologic resources as well as about the state's geologic hazards. It is distributed to most schools and libraries in Utah to further geologic education.

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FROM THE DIRECTOR'S DESK
Continued from Page 2

cause we don't do site investigations for individuals, we refer them to published information if it exists and often recommend that they hire a geologist in the private sector to check out their concerns. Some areas, such as the Sugar House quadrangle, has easily accessible information at 1:24,000. For other areas, less information has been collected and the information that has been collected is difficult to access. The hazard information compilation program (feature article of this Survey Notes, page 3) is specifically designed to make this type of information more easily available to the public as well as to planners and geologists. In five or six years, we hope to have the state's known geologic hazards compiled in a usable form for a layperson.

The UGMS statute mandates that we respond to local and state agency requests for site investigations. In support of that role, the UGMS Site Investigation Section has undertaken a wide variety of projects throughout the state for various cities, towns, counties, and state agencies. As part of a recent reorganization, emphasis within the section will be placed primarily on performing site evaluations for critical facilities, supporting other state agencies in their administrative or regulatory roles, and conducting longer term studies. As always, public health and safety are of paramount importance to the UGMS, and the section will continue to respond to requests where those considerations are of primary concern. However, in some areas, particularly those dealing with land-use issues, or where expertise can be developed within the responsible regulatory or administrative organization, the section will assume the role of technical reviewer and, where appropriate, provide training to state and local personnel rather than undertaking the geologic study themselves. Two major areas being targeted for the review/training mode are the evaluation of consultants' reports submitted to cities and counties under hillside development or geologic hazard ordinances, and site evaluations for individual wastewater disposal systems. To facilitate the report review process, the UGMS is cooperating with the Utah Section of the Association of Engineering Geologists in developing guidelines for the preparation of engineering geology reports. A similar kind of project is being contemplated with the Utah Health Department to assist them and local county health districts to develop the in-house expertise required to deal with the geologic aspects of wastewater disposal.

A need long recognized by the UGMS is for area-wide engineering geologic studies in many parts of Utah. Such studies provide both basic data and interpretive information on geology, hydrology, and geologic hazards for planning purposes in areas experiencing rapid growth or other types of development pressure. When such hazards are identified, the local planning agencies can then request site-specific reports done by the private sector for those areas that may have hazard problems. The Site Investigation Section has undertaken a limited number of city-wide or regional studies in the past. Some, like Special Studies 58 "Engineering Geology of the St. George Area, Washington County, Utah", were initiated and financed entirely by the UGMS in response to a perceived need. Others, such as Special Studies 66 "Engineering Geology of Park City, Summit County, Utah", were a priority request of a public entity and were cooperatively funded on a fifty-fifty cost-share basis. The UGMS intends to seek additional opportunities through the Site Investigation Section to cooperate on a variety of these longer term, in-depth projects around the state. The criteria used to determine in which projects to participate include: the ability to provide new data and/or increase the general knowledge and understanding of engineering geology in Utah, applicability to answering the questions or solving the problems posed by the requesting agency, potential benefit to the greatest number of Utah's citizens, and availability of resources. Cities, towns, and counties, or other agencies, interested in pursuing the possibility of initiating a cooperative study should contact William Lund, Chief of the Site Investigation Section. I'd like to thank William Lund for his contribution to this Director's Corner. ∎

Genevieve Atwood

GREAT SALT LAKE LEVEL

Date (1986)	Boat Harbor South Arm (in feet)	Saline North Arm (in feet)
Jan 1	4208.90	4208.15
Jan 15	4209.00	4208.25
Feb 1	4209.15	4208.45
Feb 15	4209.35	4208.55
Mar 1	4209.90	4208.95
Mar 15	4210.20	4209.45
Apr 1	4210.50	4209.55
Apr 15	4210.85	4209.80

Source: USGS provisional records.

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